

A Register of Earthquakes in California, from 1800 to 1863

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Earthquakes in California

As the subject of earthquakes for some years past has engrossed much of the attention of scientific observers, I have, at the request of several members of the Academy, made out a complete report upon the occurrence of those phenomena upon this coast, as far as personal observation is concerned, and also so far only as we have authentic records prior to the occupancy of the present State of California by the American Government.

The present paper contains, probably, all that can be verified, and places the subject in a form to which future reference may be made by other observers abroad; thus enabling them and ourselves also, to bring together the statistical facts which, it may be hoped, will help to form some rational theory in future years relating to the causal agency of those phenomena, as well as the physical laws governing their action.

In this paper I have reduced the periods of their occurrence for the thirteen years past to astronomical time, in all instances where the hour on which the shocks occurred have been known with certainty, and, without attempting to combat any theory that has been advanced, or the suggestion of another relating to their origin, their history has been left as a record of facts, which will become useful when others of like character accompany them. Our record, in this State alone has reached a little more than one-tenth of the number on which M. Mallet has founded his theory of their origin, and which were drawn from all parts of the world, and although this may seem a large proportion for this district of country alone since 1850, it is not to be presumed that a greater frequency of shocks have occurred here than elsewhere, but that the same attention has not been bestowed in recording their occurrence in other countries where they are known to be much more frequent and severe than upon our coast. It might be asked why, if such unquestionable frequency occurs within the

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limits of this State we are not subject to momentary destruction from their effects; the answer to this is found in the preceding paragraph, from which cause it will be seen that our experience is more apparent than real, relatively, and farther still, we should find a much greater frequency of shocks, beyond all doubt, if the instruments for their registry in different parts of the State were more plentiful than at present.

There is no good reason for the supposition that we are in more danger from these phenomena than upon the Atlantic border, for the reason that we are so far removed from the centers of immediate and violent volcanic action, that it would require dangerous tension of the imagination to place California within the range of those physical causes which are so conducive to violent, repeated, and destructive earthquakes. This State cannot be

considered more subject to earthquakes than it is to volcanoes, relatively, and this is said too in the face of our own records relating to the former. We need have little fear from these disturbances so long as we are so far removed on either hand from the great centers, and even from the terminal points of those centers of volcanic disturbance, from the action of which such disastrous consequences have, and will again follow to their immediate districts.

A moment's consideration will convince the most sceptical of the prevailing fallacy relating to this subject. In the first place, we are situated between two great termini of active volcanic ranges, the nearest being Colima, 1,200 miles south, the other on the coast of Alaska, more than 1,300 miles to the north; the distance inclusive between the points being nearly or perhaps quite 2,600 miles, in which NO active volcanic vents abound, unless we make an exception of Mounts Hood and St. Helen in Oregon, of which the testimony is somewhat dubious, and the nearest of which is 700 miles. To the east there are no volcanoes for a distance of 2,500 miles, and to the west for a much greater distance than in either of the other directions. This, certainly, should be sufficient to palliate the fears of the timid, in some degree at least, and to silence in part also the sensational articles which appear from time to time in the press of this and the eastern States, as to California being an oven within the range of active volcanic action, and a volcanic country.

In preparing this paper I have endeavored to obtain, as far as possible, the most correct information relating to the history of these phenomena in former years. It is my desire also to correct some of the misrepresentations and statements current relating to the severity of earthquake shocks in this country during the earlier periods of its history.

I have at the present time some additional information relating to the great earthquake of 1812, which did not appear in my first paper on this subject, and which must now be placed on record. These facts relate more to the phenomena occurring during that year, rather than to the destruction of the missions, all of which will be found in their proper place below.

From careful inquiry of the early settlers and residents I cannot learn that any more than one earthquake has occurred which was in any considerable degree of a serious character, and but one which has caused the destruction of either life or property to any extent.

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This earthquake occurred in the month of September, 1812, and destroyed the Mission San Juan Capistrano, in Los Angeles County, and the Mission Purissima (Viejo) in the County of Santa Barbara. The following is the history of that event as obtained from the older native inhabitants and foreign residents on the coast at that time.

The day was clear and uncommonly warm; it being Sunday the people had assembled at San Juan Capistrano for evening service. About half an hour after the opening of service, an unusual loud, but distant rushing sound was heard in the atmosphere to the east and also over the water, which resembled the sound of strong wind, but as it approached no perceptible breeze accompanied it. *The sea was smooth and the air was calm.* So distant and loud was this atmospheric sound that several left the building attracted by its noise.

Immediately following the sound, the first and heaviest shock of the earthquake occurred, which was sufficiently severe to prostrate the Mission Church of San Capistrano almost in a body, burying in its ruins the most of those who remained behind, after the first indication of its approach was heard.

The shock was very sudden and almost without warning, save from the rushing sound above noted, and to the severity of the first shock at that moment is to be attributed the loss of life that followed.

The number reported to have been killed outright, is variously estimated from thirty to forty-five (the largest number of persons agree on the smallest number of deaths given), but in the absence of records such statements should be received with many grains of allowance, where memory alone is the only means left, and the term of forty-three years has elapsed before the period at which this account was placed on paper. A considerable number are reported to have been badly injured.

There is a universal agreement on this point with those from whom these facts were derived, viz.: *that the first shock threw down the entire building, and that a large number of persons were in it at that moment*, and under the circumstances it would be most singular if no deaths were caused by such an event.

It is now nine years since the above facts were published, and in March, 1864, a writer to me unknown, corroborates this statement relating to that Mission in these words. "The church thrown down at San Juan Capistrano by an earthquake in 1812, was a well built-affair of stone and cement. The cupola or short steeple falling over the church completely destroying the building."

The motion of the earth is described as having *lifted vertically*, attended by a rotatory movement. *No undulatory* motion is described by any one. Dizziness and *nausea* seized almost every person in the vicinity.

A heavy, loud, deep rumbling, accompanied the successive shocks that followed, which were five in number, all having the motion above described, though comparatively light in their effects to the first. The sounds attending the phenomena came apparently from the South and East.

In the valley of San Inez, to the south and west of Santa Barbara, the church now known as the "Mission Viejo" (La Purissima), was also completely destroyed. At this locality there were also a number of lives lost, but what number is as yet very uncertain. The distance between Capistrano and San

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Inez is about one hundred and seventy miles. The shock which destroyed this building occurred about one hour after the former, and the greater portion of the inhabitants had left the building but a few minutes before it fell, service having closed. The first shock felt here prostrated the building, as in the preceding case.

A Spanish ship which lay at anchor off San Buenaventura, thirty-eight miles from Santa Barbara, was much injured by the shock, and leaked to that extent, that it became necessary to beach her, and remove the most of her cargo.

The writer above quoted corroborates the fact of a ship having been in this vicinity at the time. The distance of this ship from Santa Barbara is nearly the same as in my original statement but in a different direction. From the circumstantial details of the writer as to the ship "Charan," *alias*, "Thomas Newland," I am inclined to the belief that his statements are more entitled to adoption than my own; I therefore present his statement also and leave the reader to adopt either, so far as regards the ship and her position. "At the same time a Boston ship the Thomas Newland, known before as the Charan, commanded by Capt. Isaac Whitmore, was lying off the anchorage not far from the Gaviota Pass, Santa Barbara County."

It is an interesting fact, and at the same time somewhat remarkable, that the time which elapsed between the advent of the shocks at Capistrano and San Inez is widely variant from what we should look for, when the distance apart and velocity of motion in earthquakes are taken into consideration. If the velocity of the seismic wave in this earthquake was uniform with those of more recent times, it should have reached La Purissima in twenty-eight minutes and fifty seconds in lieu of an hour; but all due allowances must be made for a question of time in an event of this nature, and also for errors in memory of persons after the lapse of so many years.

The effect of this earthquake on the sea, in the Bay of Santa Barbara, is described as follows: "The sea was observed to recede from the shore during the continuance of the shocks, and left the latter dry for a considerable distance, when it returned in five or six heavy rollers, which overflowed the plain on which Santa Barbara is built. The inhabitants saw the recession of the sea, and being aware of the danger on its return, fled to the adjoining hills near the town to escape the probable deluge."

The sea on its return flowed inland a little more than half a mile, and reached the lower part of the town, doing but little damage, destroying only three small adobe buildings.

Here again I take the liberty of quoting the late writer above noticed, in corroboration of its effects upon the sea. "The sea was seen to retire all at once, and to return in an immense wave, which came roaring and plunging back, over the beach. This wave penetrated the low lands and gulches a mile from the shore, forming one of the most terrific sights possible to conceive."

Very little damage was done to the houses in town from the effects of the shocks, while the Mission at San Inez was prostrated almost instantly. There is no evidence that I can find, that this earthquake was felt in San Luis Obispo, though such has been the report.

In addition to my former paper I will now add some information relating

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to this and other earthquakes, touching more particularly a series continuing through a long period for such phenomena, but preceding the great event of September of that year.

So far as the archives of the old missions assist us, it is found that from the foundation of the first mission in 1769, up to the year 1800, a period of thirty-one years, not an entry was made of these phenomena. In the latter year an earthquake is recorded as occurring at San Juan Bautista, on the eleventh of October. On the eighteenth of the same month, at supper time another shock was felt, and another still at about eleven o'clock on the same night. From the records of the Presidio of San Francisco, we are able to glean the fact, that between the twenty-first of June and seventeenth of July, 1808, there occurred twenty-one shocks of earthquakes at this post.

I will here correct the popular error relating to this earthquake or series of earthquakes during that year. It is generally stated that this was contemporaneous with the earthquake which destroyed San Juan Capistrano and La Purissima; by reference to the dates it will be seen that the destruction of those missions did not occur until four years later.

The above are the only records of these phenomena that have as yet made their appearance in the archives of the province during the existence of the Mexican Government; and, from the fact that these archives are all in our possession, there is no hazard in stating that they constitute all, of which we have any positive knowledge. As they stand, they are a sufficient rebuke to the mendacity of sensational itemizers of the public press; they will find in those records, no basis on which to indite column articles of such doleful prophecies as the public of late have been surfeited with.

During a period of thirty-nine years the records of the country exhibit the fact, that there were but twenty-three days on which earthquakes occurred and were deemed worthy of record. If we compare these figures with those recorded from 1850 to the close of 1863, we shall find much more ground for prophecy during the latter period than for the eighty-two years of which records were kept on this coast previous to that time.

From the above extracts from the archives we are left to infer one of two facts; either that earthquakes were entirely unknown during the intervals of the record dates, or that they were of so trivial a character as not to merit

the notice of the early padres during this time; the latter is the probability, for we can scarcely conceive that nothing of this nature had taken place. If, however, such be the fact, it cannot be looked upon in any other light than a manifest anomaly in the history of this or any other country.

It appears from all the testimony on the subject, that in May, 1812, the south part of the State was frequently agitated with shocks of greater or less severity, and their continuance was literally incessant for about four and one-half months. Their frequency was not less than one each day or two; four days seldom elapsing without a shock. As many as thirty shocks occurred in a single day on more than one occasion. So frequent were they, that the inhabitants abandoned their houses for the greater part of this period, and lived under trees, etc., and slept out of doors at Santa Barbara.

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This period of time seems analogous in some respects to the year 1852, and was one of very marked severity on this coast, as was also the latter year; it was analogous to other periods of subterranean disturbance in other parts of the earth since the historic era began, and there is no good reason why we may not look for the recurrence of similar events in future time. But we must not lay too much stress on the destruction of the two mission churches in 1812, to guide us in an estimate of the force of this earthquake, for the construction of those buildings had but little relation to similar structures of modern date, either in strength or material.

From 1812 to 1850, the archives are silent on this subject. In the latter year our record began and has continued with little interruption to 1863, a period of thirteen years. Within that period there are but few earthquakes occurring north of the thirty-ninth parallel which have escaped notice and have not been made matter of record.

1850

During this year the following earthquakes were recorded:

- March 12th.—A light shock was felt in San José.
- May 13th.—A light shock in San Francisco. An eruption of Mauna Loa, S. I., and shock same day.
- June 28th.—A light shock in San Francisco.
- August 4th.—A smart shock was felt in Stockton and Sacramento.
- September 14th.—Smart shock at San Francisco and San José. Total number recorded in 1850, five.

1851

- May 15th.—Three severe shocks in San Francisco. During this earthquake windows were broken and buildings severely shaken. A large amount of merchandize was thrown down in a store on California Street. The shipping in the harbor rolled heavily. An eruption of Mauna Loa and shock in the Sandwich Islands same day.
- May 17th.—A light shock in San Francisco.
- May 28th.—A light shock on the Salinas.

- June 13th.—A smart shock at San Francisco. This was felt at San Luis Obispo and San Fernando.
- December 2d.—A shock at Downieville.
- December 31st.—A smart shock at Downieville. Total recorded in 1851, six.

1852

From the beginning of this year until the middle of its last quarter, no disturbances of the coast was noted until the month of November. In this month the southern portion of the State was violently disturbed.

November 26th.—The number of shocks on this day at San Simeon was *eleven*, and at Los Angeles and San Gabriel the same number. Nearly or quite the same number was also observed by parties having in charge a Government train in transit from Fort Yuma to San Diego.

This earthquake or the series was experienced over the entire country, east

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and south of Luis Obispo to San Diego and the Colorado River, covering a line of country about three hundred miles in extent.

From subsequent accounts we learn that it also reached as far as Guaymas, in the province of Sonora, Mexico.

For a period of six days subsequent to the twenty-sixth of November, the whole of this region to the Colorado, was convulsed, with slight intermissions. During this time a *mud volcano* opened on the Colorado Desert, and another south of the river; one of these was visited by a portion of the United States command under Col. Hientzelman.

December 17th.—Two smart shocks at San Luis Obispo, which fractured the walls of two adobe buildings, and threw down a part of the wall of a house belonging to, and occupied by Don Jesus Pico and family.

During the months of November and December, the southern particularly, and middle portions of California were much disturbed; shocks were experienced in those sections for sixty-five days, with variable intermissions; they were noticed as far north as the thirty-seventh parallel, but generally light in their nature. The latest date of this series was to the fifth of January, 1853, on the valley of the San Joaquin.

The period of time inclusive between the sixteenth of November (the date of the terrible earthquake at Banda Neira in the Moluccas), and the twenty-sixth of January, 1853, must be regarded as one of the most remarkable and portentous periods of the earth's history during modern times. For in that period a greater proportion of the earth's surface was convulsed by subterranean forces than has been known for many scores of years, in the same length of time.

The area most severely affected by these phenomena is included between the parallels of forty degrees south latitude and thirty-seven degrees north latitude, and extending from one hundred and twenty degrees east to the forty-fifth degree west longitude, being nearly equal to three-fifths of the equatorial, and a little more than one-half the polar circumference of the earth.

At this time the coast of eastern Asia, the Islands of the South Indian Ocean, Singapore, the fated Moluccas, the east coast of China, the north, east, and south coasts of Australia, the coast of California, Mexico (west coast,) South America, with portions of the Atlantic coast of the United States south of the thirty-fourth parallel, north latitude, shared in the general disturbance which prevailed on our own shores during this time. With the twenty-

sixth of January ceased the vibrations on this coast at that time, but we have positive intelligence that they continued much later on the east coast of China and Australia, in which countries they did not cease until the month of February. With these facts before us we cannot but believe the period included one of the most turbulent in the earth's career during modern times.

1853

- Jan. 2d.—A shock of earthquake was felt in Mariposa; this was observed in San Francisco, Bodega, and at Shasta City.
- Jan. 5th.—A shock at Corte Madeira.
- Feb. 14th.—A light shock at San Luis Obispo.

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- March 1st.—A smart shock at San Francisco, which was felt at San Luis Obispo and Santa Barbara.
- April 24th.—A light shock at Humboldt Bay.
- April 25th.—Three shocks in quick succession at Weaverville, Trinity County.
- June 2d.—Two smart shocks on the plains of the San Joaquin.
- July 12th.—A light shock at Yreka, Siskiyou County.
- Sept. 3d.—Four shocks on the Salinas and San Joaquin Plains.
- Oct. 23d.—Three heavy shocks at Humboldt Bay.
- Oct. 25th.—A light shock at Humboldt Bay.
- Nov. 16th.—A light shock at San José.
- Nov. 21st.—A shock at San Francisco.
- Dec. 11th.—A light shock at San Francisco and Mission Dolores.
- Dec. 23d.—A light shock at Shasta.

Total in 1853, 15.

1854

- Jan. 3d.—Two smart shocks in Mariposa, felt also in Shasta.
- March 2d.—A light shock at San Francisco.
- March 20th.—A shock at Stockton.
- April 29th.—A light shock at Santa Barbara.
- May 23d.—A shock at Crescent City.
- May 31st.—An earthquake at Santa Barbara at 5h. 10m. In this earthquake there were three distinct waves. The first was accompanied by profound rumbling; the second shock was preceded by a loud, rushing noise like the approach of a strong wind. About four or five seconds elapsed

between each shock. The sea was much disturbed, and a heavy surf swell came in soon after the second shock passed. This surf-wave rolled inland some thirty feet beyond the old wreck at the embarcadero. I saw the effect of this wave in July following. The inhabitants were much frightened and left their beds for the open air. Very little damage was sustained.

- June 26th.—Two light shocks in Placer County.
- July 10th.—One shock at Georgetown.
- July 14th.—A shock at Georgetown.
- Sept. 14th.—A light shock at Nevada.
- Oct. 21st.—A light shock at Monterey.
- Oct. 26th.—A smart shock at San Francisco, near midnight. It was felt at Benicia. This shock was followed by a swell in the bay, as vessels at the wharfs swayed heavily on their hawsers.

Total in 1854, 12.

1855

The following is the record of earthquakes for this year, in the State of California, with the date and hour of the day at which they were observed:

Jan. 13th, 18h. 30m.—A smart shock occurred at San Benito and San Miguel.

It was felt at San Luis Obispo.

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Jan. 24th, 22h.—A heavy shock of earthquake was felt at Downieville, which lasted seven seconds.

This earthquake was quite severe at Gibsonville on the north, at Forrest City, Minnesota, in Sierra County, and at Orleans Flat, Eureka, in Nevada County, at Georgetown and Nashville in El Dorado County on the south, and at Keystone Ranch, in Yuba County, on the west. The entire distance north and south affected was ninety-four miles, and in a westerly line, thirty miles. The shock was preceded by a deep rumbling, and the rushing sound of wind in the distance. It shook buildings severely. A large pinnacle of rocks on the summit of the Downieville Buttes was thrown down, and some of the large fragments reached the south branch of the North Yuba, at the base of the mountain.

Feb 5th, 22h.—A light shock was felt at Wolf Creek and the north-east part of Nevada County.

April 7th, 18h.—A light shock was felt at Gibb's Ferry, Trinity County, and was experienced as far north as Callahan's Ranch, at the head of Scott's Valley, Siskiyou County.

June 25th, 14h.—A smart shock was felt at Santa Barbara, and extended northward as far as the valley of Santa Maria. This shock was cotemporaneous with one that occurred in Switzerland.

July 10th, 9h. 30m.—A light shock was felt in Georgetown, El Dorado County, which lasted about four seconds.

July 10th, 20h. 15m.—A severe shock at Los Angeles, which did considerable damage.

There were four distinct shocks during the earthquake, with a period of about two or three seconds elapsing between each vibration. During their continuance the ground opened in several places, in fissures of one or two

inches, the marks of which remained for several days afterwards. There were some twenty-six buildings in the city more or less injured, which I personally examined, and among them the church, the west wall of which was split from top to bottom in two places, the fissures being from one to two and a half inches in breadth, running entirely through. The east wall split at a slight angle from the perpendicular, and had but one fissure. The walls of the Star Hotel were split in several places, and on the west side there appears to have been a decided horizontal motion, as the wall was displaced on that side horizontally to the depth of about one inch, and some eight or nine feet in length. The amount of displacement decreased from the west end of the building towards the center. It is a fact worthy of note, that none of the *thin* adobe walls of the buildings suffered injury, while most of the *thick*-walled buildings were injured to a greater or less extent.

During the earthquake, many articles were thrown down; those that were standing on shelves against the east end of the buildings were thrown westward on to the floor, and those on the opposite end of the buildings were thrown back in an inclined position against the walls. These features were noticed in the drug stores of Doctors Winston and Hope, situated on the main street, and a short distance west of the church.

The meteorological condition of the atmosphere was rather unusual, and is described as follows: The day was unusually warm and sultry, attended with a little rain, (the latter very unusual) and a sudden change of temperature to unpleasant coldness. At Point San Juan there was observed considerable commotion in the water, attended with a strong rushing sound, and two unusually heavy surf swells, immediately *following the last shock*.

This shock was felt distinctly at the saw-mill, some eight miles east of San Bernardino, about seventy miles east of Los Angeles, and at Santa Barbara, about one hundred miles in a westerly direction.

Aug 12th, 9h. 30m.—A light shock of an earthquake was felt at Georgetown, which lasted about three seconds. The vibration apparently came from the north. Between this date and the tenth July there were four other light shocks, the dates of which are not recorded.

Oct. 21st, 19h. 45m.—A smart shock of an earthquake was felt in San Francisco. The buildings situated over the water were violently shaken. There was much commotion in the water of the harbor a few minutes preceding the shock, which caused several vessels to heave heavily at their hawsers and cables.

Oct 27th, 15h.—A light shock was felt in the valley of Clear Lake. On the same day a shock was felt at Downieville, which lasted about five seconds. At Goodyear's Bar it was more severe than at the preceding locality.

Dec. 5th, 11h. 20m.—The shock of an earthquake was felt at Humboldt Bay, which lasted about three seconds. There were two vibrations, the last being the most severe.

Dec. 11th, 4h.—A shock was felt in San Francisco and at the Mission Dolores; at the latter place it is represented as being quite severe.

The whole number of which I have a record for 1855, amounts to twelve only; but there may be others which have escaped my notice on account of absence from the city.

The following table will show the number of shocks for each year, and each month of the year, for six years from 1850 to 1855, inclusive.

	1850	1851	1852	1853	1854	1855	No. for each month in six years.
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January,				2	1	2	5
February,				1		1	2
March,	1			1	2		4
April,				2	1	1	4
May,	1	3			2		6
June,	1	1		1	1	1	5
July,				1	2	1	3
August,	1					1	2
September,	1			1	1		3
October,				2	2	2	6
November,			11	2			13
December,		2	1	2		2	8
Total each year,	5	6	12	14	12	11=59	59

From the above it will be seen that of the total number of shocks in six

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years in this State, forty-eight have occurred during the spring, summer, and autumn months, and eleven during the winter months.

Of the total number noted, twenty-seven have occurred from San Luis Obispo south, and of the thirty-two remaining, nine have been felt in San Francisco at the same time they were observed at San Luis Obispo, while the remaining twenty-three were felt at San Francisco and north of that point.

Notwithstanding we have had, what may, perhaps, be considered a frequency in the recurrence of these phenomena, still there are but a *very few* of the total number that would merit a moment's consideration south of the twenty-fifth parallel of north latitude, for there they would be regarded as minor affairs entirely.

From all the facts in our possession relating to the phenomena on our coast, it appears that the greatest preponderance in action and severity of effects, is exerted, for the most part, south of Point Conception, for, from this place, east, south and north, to near the Colorado, the most conclusive evidence exists of very recent volcanic action having been exerted on rather an extensive scale, and is also still persistent in several localities within the area named, though in a minor degree.

It would be interesting to examine the changes of level that have evidently taken place in this State within the last five years; but as more extended observations would greatly assist us in forming conclusions on this subject, I will defer that portion until a future day.

1856

At the close of 1855, I presented to the Academy a statement of the occurrence of earthquakes in this State for that year and a term of years preceding.

During the year just passed, I have kept a careful record of these phenomena, which have been noticed in this city, and other parts of the State, and which will be found below, with their date, and the hour of the day on which they took place; they comprise all that have occurred, with perhaps two exceptions, the dates for which were so obscure as to render it impossible to determine with accuracy the precise period of their occurrence. So far as I am informed, those shocks that have taken place in this State during the past year have not been marked with more severity than has been usual in years preceding, frequently amounting to a slight tremor, and at other times to more distinct movements; three only have possessed sufficient intensity as to command general attention during the busy hours of day.

Very few have been noticed by persons who were standing upon the earth at the period of their occurrence. By far the greater proportion were observed in high situations from the ground, and in the more retired parts of the city, or on the alluvial covering of the country to the west and south.

The total number for the past year is sixteen, and of this number thirteen were observed between sunset and sunrise.

By reference to the statistics below, it will be seen that even mountain districts, where during the day there is much less of turmoil and noise arising from business than in the populous city, that of all those noticed, none have been of sufficient

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intensity to attract the attention of the inhabitants during the hours of daylight. These facts, though few in themselves, are of importance, to disabuse the public mind in relation to the danger to be apprehended from the occurrence of these phenomena. The character which we sustain both at home and abroad, as being in constant danger of being swallowed up by these occurrences, and that our country is but a bed of latent volcanoes ready to burst forth at any moment, spreading devastation over the land, is one of the greatest fallacies that ever obtained possession of the human brain. Our State is as primitive as Massachusetts or New Hampshire, and the dangers that surround us from the sources above mentioned, are equally great as in the States just named.

We should remember that when speaking of California as a State, that we include a line of territory equaling that of the seaboard lying between Cape Hatteras on the south and the British Possessions on the north, and including eleven of the seaboard States of the Union; and when we place our comparative estimates on this basis in matters of this character, it will become at once evident that the danger of annihilation from the causes under consideration, are not of that magnitude which at first sight would appear.

Along the coast of Mexico and Central America, to the south of California from all the records that are obtainable here there appears to have been a much greater exemption from those phenomena than has been usual in former years; this seems to have been the fact, also, throughout the Pacific, Oceanic, and most of the Continental Islands along the coast of China, while to the north and north-west, beyond the fifty-fifth parallel, both volcanic and earthquake phenomena appear to have been greater than usual. This has been observable, for the most part, in the neighborhood of the Aleutian Archipelago, along the north-east coast of Japan, and in the British and Russian Possessions of North America on the Pacific, and islands of the Ochotsk Sea.

It would be interesting to know more of the predominance of these phenomena in those regions, and such information could be easily obtained from the commanders of the whaling fleet, if the proper measures were adopted to secure it.

Below will be found some interesting matter upon this subject, which took place during the past year near the Straits of Ourinach.

The earthquakes which have occurred in this State during 1856, and the period of their occurrence, is as follows:

January 2d, 10h. 15m.—This morning, a smart shock of an earthquake was felt in San Francisco. The motion of the earth was undulatory, and came apparently from the northward. A pendulum indicated a motion of about five and a half inches.

January 21st, 16h.—Quite a smart shock occurred; it was quite sharp in the south-west part of the city.

January 28th, 3h.—At the town of Petaluma, Sonoma County, a shock of an earthquake occurred. It was sufficiently heavy to awake persons from their sleep.

January 29th, 0h. 45m.—A slight shock was felt in San Francisco. It was observed also at the Mission Dolores. There were three distinct tremors, with

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short intervals elapsing between. The motion was apparently from the west-ward.

February 15th, 5h. 25m.—A severe shock of an earthquake was felt in San Francisco, the duration of which was about eight seconds. Persons sleeping were aroused, and many persons left their beds and sought the street. There were two distinct shocks, the second very light and scarcely perceptible. The motion was *undulatory* and *vertical*, and at the end of the first shock a very strong, profound jar, with which it ceased.

The upper part of a building on Battery Street, for seventy feet in length, was thrown down, the whole of which was above the cornice, very thin, and the mortar with which it was constructed had not become hardened, being easily removed by the fingers—it more resembled wet sand than a firm mortar.

There appears to have been but little difference in the sensation of persons situated either in upper or basement stories.

It was preceded by a deep, heavy rumbling, and the motion apparently came from the north-west. A distinct shock was felt at eight minutes past two o'clock the same morning, by persons who were awake and up at the time.

The rotatory movement was shown in the fact that small square bottles and boxes that stood upon a line, were moved from their position horizontally, describing an arc of thirty degrees and upwards, as shown by the dust upon the shelves on which they stood.

The first wave came with a force sufficient to project small articles three or four feet on the floor, from shelves on which they were placed; they were apparently all thrown in the same direction. Several clocks were stopped at precisely 5 hours 25 minutes.

All the cracks in walls and ceilings had a direction nearly north-west and south-east, and most of them had the appearance of having been produced at the moment of elevation.

The earthquake was felt heavily at Monterey, at five hours twenty minutes; it was also felt at Bodega, but no time is given.

The vessels on the coast, and ranging from San Pedro on the south to Southern Oregon, and at distances varying from eight to one hundred miles from land, did not experience any shock. They were twenty-two in number.

Up to the present date the most northern point of which we have any record of its having been felt, is at Santa Rosa, which is fifty-three miles north of San Francisco, and at Monterey, ninety miles south of the latter place; to

the east of this city we have no record beyond Stockton. This would give for its length one hundred and forty-three miles, and its breadth sixty-six miles.

Inquiry was made through the State line Telegraph at El Dorado, Nevada, Downieville, Placerville, Marysville, Sacramento, Stockton, and San José; it was not felt in any of the localities named, exeepting [sic] the two last, and at Stockton it was quite light.

If the time as given at Monterey was the same as at this city (San Francisco), the velocity of the earth-wave must have been much slower than that of the great earthquake at Simoda.

March 24th, 22h. 20m.—A slight shock was felt at Canal Gulch, Siskiyou County, also at Yreka. The motion is described as being horizontal.

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March 31st, 13h. 25m.—A light shock was felt in San Francisco. It consisted of three light but distinct tremors.

April 6th, 23h. 30m.—A smart shock was felt at Los Angeles and the Monte, people were aroused from their beds.

May 10th, 21h. 10m.—A light shock was felt in San Francisco. The shock was accompanied by a loud report, like the discharge of a cannon; people mistook it for the signal gun of the mail steamer. This was felt at Monterey, and in Contra Costa County.

May 2d, 0h. 10m.—A severe shock was felt at Los Angeles. It caused much trembling among the buildings, and considerable alarm among the people, many leaving their beds. The shock was preceded by two loud reports like the blasting of rock; it apparently came from the north-west; no damage was done.

August 2d, 5h. 20m.—A light shock was felt in San Francisco. It was sufficiently strong to awaken persons in bed; it was evidently more severe in Stockton.

August 27th, 21h. 15m.—An earthquake was felt at Mission San Juan, Monterey County. There were two distinct shocks with short intervals elapsing, the second being the heaviest. The motion is described as undulatory and coming from the west. It was felt at Monterey and at Santa Cruz.

September 6th, 3h.—A smart shock felt at Santa Cruz. It created considerable consternation and many persons left their beds.

September 20th, 23h. 30m.—A very severe shock was felt in different parts of San Diego County, and at that town. At Santa Isabel the ceilings of the dwellings were shaken down; the cattle stampeded and ran bellowing in all directions, and the Indians seemed equally terrified. The walls of the adobe buildings were many of them cracked. The motion is described as oscillatory. A light shock occurred on the following Monday morning.

November 12th, 4h.—A smart shock occurred at Humboldt Bay. Another shock was reported but no date given.

From the record before us it will be seen that of fifteen, the total number of earthquakes recorded during 1856, seven have been felt in San Francisco in common with other parts of the State; seven have occurred south of this locality that were not observed here, and four north of it. Of the seven shocks noticed here five only were not observed in any adjacent district, and may be considered as strictly local. The periods of the year at which the shocks have occurred, are as follows: During the winter months, five; during the autumn, three; during the spring and summer, six. None have taken place between the vernal and autumnal equinoxes.

We have records of considerable and violent volcanic phenomena throughout the northern seas, and islands both to the east and west of Alaska. The Russian frigate *Dwina*, while lying at Shuam Shu, brings intelligence of the

outburst of a volcano in that vicinity about the twenty-second of June, and on the twenty-fifth of the same month passed through fields of floating pumice; the latitude by observation being fifty degrees fifty-three minutes, and longitude one hundred and fifty-eight degrees thirty-two minutes east, per chronometer.

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An interesting account of a submarine volcano was reported by the Captain of the bark *Alice Frazer*, in latitude fifty-four degrees thirty-six minutes, longitude one hundred and thirty-five degrees west, which is as follows: A portion of the whaling fleet, four in number, were running through the Straits of Ourinack, on the twenty-sixth of July last; while passing the straits a submarine volcano burst out, sending a column of water several hundred feet upward; immediately following this, immense masses of lava were projected into the air, and the sea for miles and for days afterward, was covered with floating fragments of pumice. The ships *Scotland* and *Enterprise* were nearer the volcano than the ships *Frazer* and *Wm. Thomson*; on the decks of the two former considerable pumice, lava, and ashes fell. There were seven vessels in the straits at the time of the occurrence, three of which names I could not learn.

The outburst was accompanied with violent shocks of earthquake. It is the opinion of Captain Newell, of the *Alice Frazer*, that considerable shoaling has been the result of this submarine action.

On the Direction and Velocity of the Earthquake in California, January 9, 1857—By Dr. John B. Trask

The earthquake which occurred in various parts of this State, on the morning of the ninth January last, excited at the time considerable attention. This arose from two causes. First, from the varied reports that appeared on the following day through the press of the city, detailing its occurrence in remote mountain towns, and for which there was no foundation. Secondly, from the the great extent over which the commotion was felt, as was subsequently proved.

Immediately following the occurrence of the phenomenon, letters were addressed to all the principal towns between Mariposa and Downieville, east of the valleys, for the purpose of learning how far the shocks may have extended eastward of this city. These letters were forwarded by the Pacific Express Company to their agents, and through them answers were returned in every case but two through the same source. From the facts thus obtained, it was found that in no locality east of the foothills, *was any shock felt on that day or night*.

Another report, equally unfounded, reached us on the arrival of the steamer from the southern coast, to the effect that several houses had been demolished in San Diego from its violence, while the facts in the case are *that the steamer left that port twenty-four hours before the shock occurred there*.

This earthquake, or more properly speaking the series of shocks that began on the night of the eighth in this city, and which continued in the south part of the State during the following day and night of the ninth, was probably the most extensive of any on record on this portion of the Pacific coast, excepting, perhaps, that of the wave of the Simoda earthquake in December, 1854. The linear distance over which we are able to trace its course, amounts to six hundred and two miles, and its breadth, so far as now ascertained, is two hundred and ninety miles. It has all the appearance of having been the terminal movement of some more violent commotion at a distance from our coast.

From the best evidence obtainable at present, it seems to have had its origin

to the west and traveled in an easterly direction. This is conclusively proved from the fact that it was felt earlier at San Francisco than at any other locality east of this city within the State. We have no record as yet of its occurrence along the coast of Mexico or of Oregon.

I have been able to determine with considerable accuracy the period of time at which the shock between eight and nine o'clock on the morning of the ninth took place, at four localities east of the City of San Francisco, in this State; as the shock at that hour seems to have been more generally noticed than those which either preceded or followed it here or elsewhere, though at this city it was much less marked than the shocks at 1h. 33m., 4h. 15m., and 7h., these three latter occurring at those hours of the morning when most persons are sleeping. The shock at 7h., produced a circular motion in the pendulum, the diameter of which was about five inches. The oscillations of the pendulum in all the others were in an easterly and westerly direction.

The precise period of time at which the shock took place at San Francisco, between eight and nine o'clock, is determined by the stopping of a time-piece belonging to J. W. Tucker, whose rate of error was three seconds fast. The time at San Diego was furnished by Mr. Cassidy, of the army, and that of the Tejon Reserve is by persons at that post. To private gentlemen at Sacramento and Stockton we are indebted for the time at those places. The accompanying table of latitudes and longitudes of localities named, gives the hour at which the shock took place at each; the difference or elapsed time, from which the velocity was deduced, are the mean times corrected for the places named, the time as given above being taken as the standard at San Francisco.

It is proper to state that three minutes four seconds, was the greatest error in time found, and the least was twenty-two seconds:

Locality.	Lat.		Lon.		Time of shock.			Elapsed Time.		Velocity.
	°	/	°	/	h.	m.	s.	m.	s.	miles.
San Francisco	37	48	122	25	8	13	30	0	00	00
Sacramento	38	32	121	23	8	20	00	7	30	66
Stockton	37	52	121	34	8	23	00	9	30	65
Tejon	35	00	118	46	8	45	00	32	30	60
San Diego	32	42	117	13	8	50	00	36	30	70

The velocity is given in miles per minute, and by dividing the sum of the same by their number, it will be found that the movement of the wave at that time averages a fraction over 6.2 miles per minute.

The results obtained from the above data approximate closely the deductions of Prof. Bache on the wave which reached our shores and resulting from the earthquake at Simoda on the twenty-third December, 1854, and which will be found in a paper read by that gentleman at the meeting of the American Association for the Advancement of Science, during the early part of last year.

From the facts before us, there can be but little doubt of the direction of the commotion, and that it proceeded from the west, or a little south of that point. The motion of the earth, as described at the different localities at which it was felt, with the motion of the pendulum—which was slightly south of a west

line—leads to that conclusion. Time is an important element in aiding us to form correct conclusions regarding these phenomena, and it is to be hoped that our friends in different parts of the State, in reporting the same, will be precise in this particular. Of the incidents attending the shocks, many and varied reports have reached us; it seems to have acted with greater violence in the vicinity of the Tejon Reserve and upper Tulare County than at any other place. It is most remarkable that so small an amount of intensity of force was manifested when the area over which it extended is taken into consideration.

The effects were felt in San Francisco several hours before they are reported to have been observed at any other place north or south. They began here at twenty minutes past eleven, on the night of the eighth, and continued till thirteen minutes past eight the following morning—six shocks occurring in the interval; while to the south, the first shock noticed at the Tejon, was at six hours thirty minutes, on the ninth. In Los Angeles they continued at long intervals through the day until twenty-three hours thirty minutes of the same date. I have learned from persons who were present in Los Angeles at this time, and also at the shock of the fourteenth July, 1855, that the severity of the latter exceeded that of the ninth January last past.

1857.

During the past year there has been rather a frequency in the occurrence of the phenomena of earthquakes; and, with the exception of two, there have been none that were particularly remarkable either for extent of surface affected or severity of action. In one, that of the ninth of January, the greatest extent of surface, and greatest intensity of action was manifest. Its principal force seems to have been expended in the more southerly portions of our State, and in the immediate vicinity of those volcanic (?) vents found at different localities upon the Colorado Desert. It is manifest, however, that this shock and those which preceded it on the night of the eighth, had their origin to the west of our coast, as the times of occurrence of the shock at different localities most fully prove. This matter was fully discussed in my previous paper, "On the direction and velocity of the earthquake of January 9th, 1857," read before this Society March 30th, which will be found in their proceedings.

The other shock of greatest extent, on the second of September, extended over an area of about two hundred miles, but was marked by no particular severity or injury, except that of fright to those who experienced it.

The whole number that can be authenticated as occurring during 1857, amounts to seventeen, being greater than the number recorded in 1853 and 1856; and it would seem probable from our records that this number is the maximum to which we shall probably be subjected in this State.

From the Sandwich Islands we have no news of earthquakes save one, which is here inserted: "A very severe shock of earthquake was felt at Kawaihae, Hawaii, on the twenty-fourth of February, the most severe that the residents there have had for many years."

The arrival of the whaling fleet from the Northern seas brings no intelligence of the occurrence of these phenomena, as was the case of the preceding year;

hence, the presumption is, that subterranean action has not been violent in those distant regions during the year just passed.

On the coast of Mexico, and inclusive between the twenty-fifth and thirty-second parallels, we have received intelligence of the occurrence of one earthquake, which appears to have been felt on both shores of the Gulf of

California for a distance of nearly two hundred miles, both north and south. We have no records south of that point.

The shocks which we can authenticate within the limits of our own State, are as follows:

January 9th.—This shock was felt from Sacramento to the southern boundary of the State. It was preceded by three smart shocks the night and morning previous. At Santa Barbara water was thrown over the surface from a shoal well, seven feet deep, the water in which was less than three feet in depth.

January 18th, 9h.—A light shock at Martinez and Benicia.

January 20th, 8h. 30m.—A smart shock was felt at Santa Cruz and Mission San Juan.

January 21st, 23h.—On the evening of this day a smart shock was felt at Mariposa. The wave and sound seemed to travel from north-west to south-east. It was accompanied with a report like that of a distant gun.

February 5th, 7h.—A smart shock was felt in San Francisco, which shook the buildings that are situated on made-ground very severely, while those situated on firmer bottoms were affected. This shock was felt at Oakland and Stockton, but was not felt at San José or Sacramento, as reported at the time.

March 14th, 15h.—A severe shock was felt at Santa Barbara and Montecito. It was momentary in duration, attended with a loud report.

March 23d, 12h. 27m.—A light shock in San Francisco.

May 3d, 22h.—A smart shock at Los Angeles and the Monte.

May 23d.—A light shock at Los Angeles; a report also that a severe shock had been felt at Fort Tejon.

June 14th.—A shock was felt at Humboldt Bay. On the same day several severe shocks were experienced at the Penal Island (Carmen), Gulf of California, and which extended almost ninety miles north and south of the island.

August 8th, 11h.—A smart shock was felt at Rabbit Creek, Sierra County.

August 29.—A severe shock at the Tejon Reserve. No time is given.

September 2d, 19h. 45m.—A light shock at San Francisco. This shock was felt at Sacramento, Marysville, Nevada, San Juan, Downieville, and Camptonville.

September 14th, 2 P.M.—A light shock in San Francisco.

October 19th, 18h. 30m.—A severe shock of an earthquake in San Francisco.

October 20th, 12h. 8m., 12h. 35m., and 13h. 15m.—Three other shocks occurred; the last was equally severe with that of January 9th, at 8 A.M. People were much frightened, and left their beds. The shock was felt at San José, but not at Oakland.

November 8th, 8h. 45m.—A shock at San Francisco, which was felt at Oakland and Bodega.

December 23d, 7h.—A light shock at San Francisco.

Of the whole number which have occurred during the year, two only have been felt at San Francisco that were not experienced at other localities, and four others have occurred which have been felt in common at other portions of the State—thus making about one-third of the whole number that were in common here and elsewhere.

Eight of the aggregate have occurred between the summer and winter solstices.

Seven have occurred during the spring and summer months, and ten during the winter and autumn.

Eight have occurred between the vernal and autumnal equinoxes.

1858.

During the past year we have had occasion to note the occurrence of eight shocks of earthquake in this State. This number is one-half less than that in 1857, and one-third less the number in 1856. The shocks, with one exception, have been unmarked by anything like violence, being little else than mere vibrations or tremors, not noticeable by the great majority of the people. They are as follows:

February 10th.—A smart shock at Kanaka Flat, Sierra County. No time noted.

February 15th, 4h. 20m.—A light shock in San Francisco. Was observed in the County of San Mateo ten miles south of the city.

August 19th, 22h. 10m.—A light shock in San Francisco. The motion was east to west, and was undulatory.

September 2d.—A smart shock at Santa Barbara, no time given.

September 3d, 0h. 40m.—A smart shock in San José. This shock was felt at Santa Cruz, twenty-five miles west, and was evidently more marked in strength at that locality. No damage.

September 12th, 19h. 40m.—A smart shock at San Francisco. The motion was from north to south. There were two vibrations with undulatory movements lasting about fifteen seconds.

September 26th, 1h. 26m.—A light shock at San Francisco.

November 26th, 0h. 24m.—A heavy shock at San Francisco. This shock was by far the heaviest during the year, it awoke most people from slumber and created no little alarm; persons left their beds and sought cooler situations with less attire than is usually worn. The iron pillars in the second story of the custom house have separated from the ceiling above about half an inch, and are supposed to have settled from the effects of the shock; I much doubt the alleged cause of this displacement, as the pillars below present no indication of similar disturbance. This shock was felt at Oakland ten miles east of the city, but was not felt at Stockton, Sacramento, nor Marysville. It was evidently confined to an area of ten or twelve miles.

1859.

- January 25th, 20h. 20m.—A heavy shock of earthquake was felt in Trinity and Shasta counties. It was felt at Weaverville, Shasta, and Horsetown.
- April 4th, 13h.—Quite a severe shock was felt at San José. There were several vibrations, apparently from north to south.
- August 10th, 22h. 35m.—A smart shock was felt in this city (San Francisco).
- September 26th, 6h. 10m.—A smart shock at San Francisco.
- October 5th, 13h. 18m.—A very smart shock at San Francisco.
- November 27th, 19h. 15m.—A light shock at San Francisco.
- December 1st, 0h. 50m.—A smart shock at San Francisco. Felt at Oakland and Benicia.

- December 1st, 14h. 10m.—Several successive shocks were felt at San Bernardino; several of them were quite heavy, causing much alarm. No damage was done.

Whole number of shocks during this year was eight.

1860.

During the year last past this portion of the Pacific coast has been but little disturbed by earthquakes. There have been but three during this period that can be well authenticated, and one, viz.: December 21st, whose character is somewhat doubtful.

The shocks that have occurred are as follows:

March 27th.—A severe shock was experienced at Los Angeles and vicinity, which was not productive of any damage to person or property. No time is given in the account.

March 15th, 11h.—A violent shock was experienced at Sacramento; the wave passed through the counties of Placer, Nevada, El Dorado and Plumas. At Iowa Hill the church bells were rung, also at Sacramento. At the latter place and at Forest City, clocks, in many of the buildings, were stopped. This earthquake extended to the eastern base of the Sierra Nevada. At Carson City it occurred at 10h. 45m. and very violent; goods were shaken off the shelves in many of the stores, and a general panic and stampede prevailed.

November 12th.—A smart shock was felt at Humboldt Bay and its vicinity, but no damage was done.

December 21st, 6h. 30m.—At San Francisco a series of light vibrations of the earth occurred, which continued with but two remissions for the space of half an hour. These vibrations were not perceptible to persons in the building otherwise than by mercurial column, which was equal to seven inches of the barometer, and was the mercury gauge of an air pump that had remained stationary at twenty-four inches for the space of four hours. At this time the column in the gauge began to show much disturbance by oscillating up and down in a very rapid manner without any apparent cause; the stop screws (Faraday's) were all tried at the moment and found perfectly tight as they had remained for hours previous.

The oscillations were watched carefully by Mr. J. Roach and myself for half an hour, at which time they ceased. The maximum of the mercury column was a fraction over an inch, which was attained through vibrations of one-fourth to one-eighth of an inch rapidly repeated and continuous, and as gradually, through a series of lighter vibrations, the displacement would diminish and the column subside to its former level; this was three times repeated, the column at no time being at rest. The period of time occupied by the column in reaching its maximum of disturbance each time was from eight to twelve minutes. There was no apparent cause for this disturbance, unless it be attributable to a series of light vibrations of the earth occurring in a vertical direction, and to that cause I am disposed to assign it.

The passing of carriages on the street did not affect these vibrations of the column, for they continued in the same manner when those vehicles were not passing. While the oscillations were going on, I took a sledge and struck some half a dozen blows on an anvil block in the workshop, which did not make any perceptible difference in the movements of the column; after it had come to rest, the same experiment was repeated, but the column did not in any manner react to the concussion thus produced.

1861.

During 1861 there has been but one earthquake recorded in the State.

July 4th, 16h. 11m.—A severe shock of earthquake occurred at San Francisco. It consisted of three distinct waves following each other in very rapid succession. Its effects to the east of the city in the San Ramon Valley were more severe. Near the house of Mr. Larabie it opened a large fissure in the earth. In the vicinity of Mr. Porter's it opened a new spring of water, and a small running stream was also caused near Mr. Hunt's. For several days after, light shocks were repeated at intervals.

1862.

September 29th, 15h. 5m.—A very smart shock of earthquake at San Francisco. This was felt at Petaluma.

December 23d, 20h. 19m.—A smart shock at San Francisco.

1863.

During the year 1863 we have had five earthquakes, and unmarked by any serious event.

January 25th, 2h. 20m.—A severe shock was experienced at San Diego, continuing from five to eight seconds. There was no undulation in this instance, the shock consisting of a series of sharp jars. It was preceded by a profound rumbling sound.

February 1st, 16h. 1m.—A very smart shock at the Mission San Juan, Monterey County. At Gilroys [sic] the shock was felt (or another) fifteen minutes later. The latter town is near twelve miles east of the Mission. At both

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localities the motion was undulatory. The shock was not felt at Monterey, twelve miles west of San Juan.

June.—A smart shock at San Francisco.

July 15th, 10h. 19m.—A smart shock at San Francisco.

August 1st, 11h. 6m.—Two light shocks at San Francisco about one hour apart.

December 19th, 12h. 38m.—A very smart shock was felt throughout the city; directly afterwards another and more severe one occurred. The first was a sharp, sudden jar, the second undulatory. The accuracy of the telegraph operator at Santa Clara enables us to form a correct idea of the course of this wave. His time was 14h. 44m. 31s., and within twenty-nine seconds of true time. The elapsed time is 7m. 31s., and gives for the direction of the seismic wave a course north and south (in lieu of east and west in my first notice which was thus in error.) I take this opportunity to express the thanks of the Academy to this operator for his accuracy and kindness in furnishing us dates in this and other phenomena of scientific and public interest.

The figures derived from our statistics furnish us the following interesting results as to the frequency of shocks in one season of the year more than in another. The tables below furnish the details.

It is found from these figures that during the thirteen years ending December, 1863:

- First
- The number of days on which earthquakes have occurred, is one hundred and ten.

- Second
 - The month in which the greatest number have occurred is January, being sixteen; and the months in which the least number have occurred, is April and February, the sum of each being six.
- Third
 - The winter months have given the largest number in the aggregate, the sum being thirty-four. The summer months the smallest number; their sum being twenty-three. The spring months have given twenty-four, and the autumn months twenty-nine.
- Fourth
 - The number of shocks between the equinoxes foot up thus. Between the autumnal and vernal equinoxes the sum is sixty-four; between the vernal and autumnal equinoxes, the sum fifty-two.
- Fifth
 - The number of shocks that have taken place between the solstices stand thus. From the winter to the summer solstice the sum is fifty-four. From the summer to the winter solstice, the sum is fifty-nine.

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Table 1.—*Giving the number of shocks in each month of the year, for thirteen years.*

Table.	1850	1851	1852	1853	1854	1855	1856	1857	1858	1859	1860	1861	1862	1863	Total.
Jan.				1	1	2	5	4		1	1			1	16
Feb.				1		1	1	1	1					1	6
March.	1			1	2		2	2			1				8
April.				2	1	1	1			1					6
May.	1	3			2		2	2							10
June.	1	1		1	1	1		1						1	7
July.				1	1	2						1		1	7
August	1					1	2	2	1	1				1	9
Sept.	1			1	1		2	2	4	1			1		13
October				2	2	2		1		1					8
Nov.			1	2			1	1	1	1	1				8
Dec.		2	1	1		2		1		2	1		1	1	12
Total	5	6	2	13	11	12	16	17	7	8	4	1	2	6	111

Table 2.—*Number of shocks occurring between the dates of the equinoxes and solstices, for thirteen years.*

Table.	Sept. 20th to March 20th.	March 20th to Sept. 20th.	Dec. 21st to June 21st.	June 21st to Dec. 21st.
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1850	1	4	2	3
1851	2	4	5	1
1852	2			2
1853	10	5	8	7
1854	5	7	6	6
1855	8	4	4	8
1856	7	9	9	7
1857	9	8	8	9
1858	4	3	3	5
1859	6	2	2	6
1860	4		3	1
1861		1		1
1862	1	1	1	1
1863	3	3	3	3
Total	64	52	54	60

I regret that my records of the occurrence of earthquakes upon the east coast of the United States is not more complete than it is, and also that it does not extend through an equivalent period of time as our own, from 1850 to date; but I have no authentic records of their occurrence on the other side later than 1854; my business at that time, and the subsequent period that has elapsed, being such that I was not able to maintain their continuation. In order to prove the statement made on a preceding page correct as to our relative immunity on this coast over equal extent of territory, I here subjoin the totals on both coasts during that period of time. This statement will also include those shocks which were matters of record belonging to the West India Islands, and which properly belong to the eastern-coast series.

The figures relating to this matter, stands thus:

In California during 1850, five shocks; 1851, six shocks; 1852, two shocks; 1853, thirteen shocks; 1854, eleven shocks. Total, thirty-seven shocks.

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In United States, east coast. 1850, three shocks; 1851, seven shocks; 1852, ten shocks; 1853, thirteen shocks; 1854, eleven shocks. Total, forty-four shocks.

Balance against east coast, seven shocks.

West India Islands. 1852, seven shocks; 1853, three shocks; 1854, one shock. Total, eleven shocks.

These inclusive with the continental series foot up eighteen days on which shocks occurred in excess of this coast during the same period of time, and thus shows a margin of greater frequency of little more than thirty per cent.

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